KAWAILII BRIDGE
(Kawaili Stream Bridge)
Spanning Kawailii Gulch at Hawaii Belt Road
Paauilo
Hawaii County
Hawaii

HAER No. HI-94

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
U.S. Department of the Interior
National Park Service
Oakland, California

HISTORIC AMERICAN ENGINEERING RECORD

KAWAILII BRIDGE
(Kawaili Stream Bridge)

HAER No. HI-94

Location: Hawaii Belt Road [State Route 19] between Paauilo and Kukaiau
Paauilo
Hawaii County, Hawaii

Mile post 34.88 to mile post 35.09, Route 19.

U.S.G.S. Kukaiau Quadrangle, Hawaii, 1993
7.5 Minute Series (Topographic) (Scale – 1:24,000)
Universal Transverse Mercator Coordinates: 05.253590.2216910

Date of Construction: 1938

Designer: William R. Bartels

Builder: Otto Medeiros, contractor

Owner: State of Hawaii

Present Use: Vehicular bridge

Significance: The 1938 Kawailii Bridge is significant for its association with the development of the Hamakua Coast section of the Hawaii Belt Road. This road provided the vehicular link between the sugar plantations and population centers along the Hamakua Coast and the island's main port in Hilo. It is also significant as an example of a concrete tee-beam deck bridge, a type widely used by the Territorial Highway Department in the period before World War II, and typical of small Federal Aid Bridges built along the Hamakua Coast during this period. It was designed by Highway Department engineer William R. Bartels who was responsible for most of the Territorial bridge designs between 1932 and 1957, and it was built by contractor Otto Medeiros who constructed many of the federal aid bridges along the Hamakua Coast.

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Date of Report: August 2010

DESCRIPTION:

The Kawailii Bridge is a reinforced concrete bridge that rests on lava rock masonry abutments. It carries the Hawaii Belt Road (Hawaii State Highway 19) over a narrow section of the Kawaili Gulch in the Hamakua District of the Island of Hawaii. The roadway of the bridge is 24'-0" wide between 3'-0" wide 6" high curbs at the parapets of each side. The clear span of the gulch under the bridge is about 19' between abutments with a gulch depth of about 22'-6" from the bottom edge of the beams supporting the bridge deck to the concrete lined stream channel below.

The bridge does not cross the streambed at right angles, but rather at an angle of about 45°. This results in the parapets being offset. The west stanchion of the north, *makai* (Hawaiian, meaning "in the direction of the sea") parapet lies opposite (across the roadway from) the east stanchion of the south, *mauka* (Hawaiian, meaning "in the direction of the mountains") parapet.

The cast concrete parapets of the bridge are each about 44'-6" long, which includes two approximate 5' long, 3'-3" high stanchions at each end with a 34'-6" long section of balustrade that is 2'-10" high running between them. The stanchions are curved in plan, measuring 5'-1" along each long curved (road-facing) side. They have vertical sides and a flat top. The four vertical corners at the sides and the four horizontal corners at the top have a tiered pattern of square recessed corners cast into the concrete with two 1½" wide steps at each edge. Each stanchion is 1'-11" wide at the base. The tiers result in top and end surfaces that are 1'-4" wide. Each of the two stanchions that are presented to oncoming traffic at the ends of the parapets are inscribed "1938" in 3" high numerals. Each stanchion at the opposite end of the parapets is inscribed "KAWAILII" in 3" high letters.

The cast concrete balustrades of the Kawailii Bridge are 1'-0" wide at the base and top rail. The voids between individual balusters of the balustrade are formed into a cross pattern that was popular for concrete bridges in the Territory of Hawaii during the 1930s. The overall height of the voids is 14¾" and overall width is 8". The short vertical arms of each void are 6" wide and the short horizontal arms are 8" wide. Each void is in a 1'-0" wide recessed panel between each of the 6" wide, slightly projecting balusters. The top rail of the balustrade has square recessed corners that result in a 9" wide top surface and 5" wide side surfaces.

The underside of the bridge shows the impressions of the board forming used in its construction. It has six longitudinal beams that are each about 1'-6" wide and 2'-0" high. The two beams running along the center of the bridge are paired, with no space between them. There is an approximate 4' space between them and each of the other four single beams. The beams rest on a board formed concrete bearing that is about 1'-6" high and extends along the top of each lava rock masonry abutment.

Each bridge abutment is constructed of quarry-faced lava rock that is set in rough courses with flush mortar joints. At the bottom *makai* portion of each abutment are the remnants of the abutments of an earlier bridge that have the quarry-faced masonry of the 1938 bridge built atop them. The tops of these abutment remnants are about 8' above the stream bed and their width is about 16'. The faces of the abutment remnants are irregularly stepped and slightly battered and the open span between them ranges from about 17' at their top edges to about 15' at their bottoms. The west abutment remnant is un-coursed rubble masonry and a portion of the surface of the east abutment remnant is concrete, either covering underlying masonry or replacing it.

The streambed under the Kawailii Bridge is channelized, it has a flat concrete surface and is 11'-4" wide. At the sides of the streambed are concrete curbs of varying height (up to about 1'-4") with the abutments set on top of the curbs. At the time of the site visit there was no water in the stream bed.

At the east approach to the bridge a portion of the roadbed is damaged. An earthquake on October 15, 2006 caused an approximate 40' x 12' section of the earth at the makai side of the east approach to collapse into the gulch. This removed about half of the westbound lane of the roadway for a distance of about 40' from the east stanchion. The exposed earth of the damaged area has since been covered with a woven geotextile fabric. Because of this damage both lanes of traffic on Route 19 have been temporarily diverted to cross the gulch slightly *mauka* of the 1938 bridge on a section of Acrow modular steel truss bridge.

HISTORIC CONTEXT:

Historic Name

Inconsistencies in the name of this bridge were noted while researching this report. "Kawailii" (Ka-wai-li-i) is the name inscribed on the concrete stanchions of the 1938 bridge. This name is the one used as the primary name for the bridge in this report. However, the stream/ gulch the bridge crosses is called "Kawaili" (Ka-wa-ili) on historic USGS topographic maps from 1915, 1941, and 1957 in addition to the current (1993) map. In addition a main source of information about the bridge and the Mamalahoa Highway along the Hamakua Coast calls the bridge "Kawaili."[1] This name is used here as the secondary name for the bridge. For this report it is reasoned that the correct historic name of the bridge should be the name inscribed on it when it was built, Kawailii.

The Hawaiian meanings of these words are not clear. Neither "Kawaili" or "Kawailii" is listed in the standard reference of Hawaiian place names.[2] The following definitions of Hawaiian words that make up the two names were found in Pukui's *Hawaiian Dictionary*.[3] These definitions might possibly be combined to form a Hawaiian meaning for Kawaili and/ or Kawailii.

kawa: Leaping place, as a precipice from which a swimmer leaps into a pool.

kā.wā: Distance between two points, length of time.

kā.wai: Last liquor run off in distillation, very thin and watery, especially of brew made of ti root or cane.

ili: Stranded, run aground or wrecked, as a ship.

'ili: Skin, complexion, hide, pelt, scalp, bark, rind, peel.

li'i: Small, tiny.

Transportation along the Hamakua Coast region

From 1913 until April 1, 1946, the railroad was the main transportation link along the Hamakua Coast. This was the Hawaii Consolidated Railway line that was completed from Hilo to Paauilo (Hamakua Sugar Mill) in 1913. Originally, in 1899, the railroad was begun with a line that extended southward from the Waiakea terminal (about a mile south of Hilo) to the new sugar plantation at Olaa. Additional track was laid south of Olaa to Kapoho and west to Glenwood. By 1904 it was clear that the extremely low quality of sugar from the Glenwood area combined with insect pests and disease at the remaining sugar cane fields in Puna were preventing the

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[1] Patricia M. Alvarez, *Historic Bridge Inventory and Evaluation, Island of Hawaii*, (Honolulu: State of Hawaii Department of Transportation Highways Division, 1987), 291a.

[2] Mary Kawena Pukui, Samuel H. Elbert, and Esther T. Mookini, *Place Names of Hawaii* (Honolulu: University of Hawaii Press, 1974).

[3] Mary Kawena Pukui and Samuel H. Elbert, *Hawaiian Dictionary* (Honolulu: University of Hawaii Press, 1986).

railroad (before 1916 it was named Hilo Railroad Co.) from turning a profit. The solution was thought to be to extend the line into the business center of Hilo and then northward through the more heavily populated sections of the sugar producing Hamakua Coast. It also became evident that in order to properly service the sugar industry, the port of Hilo must be provided with a breakwater that would allow large vessels to be moored at the railroad wharfs and loaded/ unloaded directly. Previously, ocean swells limited the use of the company's small railroad wharf (constructed 1902 in Hilo) and most freight was lightered out to waiting vessels.[4]

Construction on the rail line north from Waiakea was begun in 1909-1910, and thirteen miles of track had been laid from Hilo to Hakalau (C. Brewer & Co./ Hakalau Mill) by the end of 1911. The remaining track was laid to Paauilo (Theo H. Davies & Co./ Hamakua Mill) by May 1913, a distance of about 34 miles from Hilo. Much of this route was along the top of the cliffs facing the ocean, with the gulches spanned by steel or timber trestles.[5] In several places, the tracks ran back into gulches for up to a half mile before turning sharply to cross the gulch in a horseshoe bend.

By 1912 the Hilo Breakwater had been constructed 2,528 feet out into the waters on top of Blonde Reef. In 1917, the breakwater extended out 5,390 feet[6] providing a sheltered wharfage utilized by the Hamakua Coast sugar mills. Transporting freight (bagged sugar from the Hamakua Coast mills to Hilo) was the primary income producer for the railroad, but passenger service was also available up and down the line. During the 1920s three excursion cars were used to transport tourists on day trips from Hilo to Paauilo.[7]

Extending along the Hamakua Coast, sometimes running near the railroad tracks, was a roadway that ran between Hilo and Waimea. This roadway, dating from at least the late 1800s, was incrementally widened and improved from an earlier system of trails. It was a wagon road that became part of the first belt road circling the island in 1902 when the final linking section was completed in North Kona and South Kohala.[8] During the early 1900s it was called Government Road.[9] This road followed the terrain much more closely than the sweeping path of the Hawaii Consolidated Railway tracks. This meant that in some places, such as at gulches where the railroad had to make a horseshoe bend, the road could cut sharper corners, descend steeper grades, and reduce the distance traveled. Although following the terrain more closely translated into reducing distances at some gulches, in the majority of areas traveling the bumpy and convoluted road path during the 1920s was much more arduous than the railroad, which became the preferred method of travel in Hamakua. "Automobile and truck traffic was limited by the narrow winding road running through the deep gulches that mark[ed] the road."[10]

The 1930s saw selective road improvements and realignments made at scattered areas of the Government Road, comprising about a quarter of the roadway along the Hamakua Coast.[11] In

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[4] John B. Hungerford, *Hawaiian Railroads: A Memoir of the Common Carriers of the Fiftieth State* (Reseda, CA: Hungerford Press, 1963), 52.
[5] Hungerford, *Hawaiian Railroads*, 55.
[6] Erwin N. Thompson, *Pacific Ocean Engineers: History of the U.S. Army Corps of Engineers in the Pacific, 1905-1980* (Washington D.C: U.S. Army Corps of Engineers, 1980), 53.
[7] P. Quentin Tomich, *Hawaii: Perspectives on Hamakua History, Ramblings through an ancient land division of Hawaii Island* (Hawaii: P. Quentin Tomich, 2008), 96.
[8] Alvarez, *Historic Bridge Inventory*, 34.
[9] E. W. Hockley & Walter E. Wall, "Hilo Forest Reserve," map, Hawaii State Library collection, January 1922.
[10] *Honolulu Star Bulletin.* "Hamakua Railroad Bridges Made Part of Road System." April 29, 1953: C4.
[11] *Honolulu Advertiser.* "Bids on Hawaii Road Projects Will be Called This Summer." May 7, 1946: 2.

1933 the road was officially named the Mamalahoa Highway.[12] Buy 1936 several large concrete bridges had been built to carry the Mamalahoa Highway across wide gulches. These were the Kaala and Kealakaha bridges, which had the thick concrete balustrades typical of the period, and the Kupapalua bridge, an arch deck bridge that had its deck supported atop an open spandrel concrete arch with a 217' span.[13] Even with these sporadic improvements, the belt road "snaked in and out of coastal valleys and crossed streams at narrow points near water level."[14] World War II priorities curtailed these short sections of improvements and straightening. By 1946, bids were again being called for on road projects deferred by the war, including "five new bridges to accommodate two-way traffic."[15]

During the depression of the 1930s the railroad reduced its operating expenses by discontinuing steam locomotive passenger service. Some passenger cars were converted to bagasse[16] carriers by boarding up windows and removing roofs.[17] However, passengers continued to be carried in gasoline or diesel motor busses converted to run on the rails.[18] During World War II, this trend reversed as military passengers became important and Hawaii Consolidated Railway converted flatcars to troop carriers to move military personnel (bound for training in Waimea) from Hilo to Paauilo. The troops were bussed from Paauilo to Waimea. Part of this route was over a paved roadway 12' wide that reached from Honokaa to Waimea.[19]

The period of railroad travel along the Hamakua Coast came to an abrupt end the morning of April 1, 1946 when a tsunami generated by an earthquake off the coast of Alaska reached the Big Island. Wave heights of up to 55' along the northeast face of the island destroyed property and drowned 24 people in Laupahoehoe and 96 in Hilo. The effect of the tsunami on the Hawaii Consolidated Railway was to rip up rails, scatter rolling stock, wash out trestles spanning gulches, and ultimately bring operations to a halt.

Shortly after the tsunami, the sugar plantations of Theo Davies & Co indicated to the Hawaiian Consolidated Railway that they would be willing to continue to utilize the rails for shipping sugar to Hilo, but the plantations of C. Brewer & Co. made a decision to begin large scale truck shipments of their sugar to Hilo for loading onto export vessels.[20] Consolidated could not remain in business on Davies' freight alone, so the decision was made to dissolve the railroad.

Even before the tsunami ended the railroad in Hamakua, plans were formed to improve the transportation network of the area by building better roads[21] and as noted above, construction of the "Hilo to Honokaa highway"[22] had been actively pursued in the years before the war. After the tsunami, the improvement work on the Mamalahoa Highway through Hamakua would still be undertaken in increments, with the "dangerous spots receiving the first attention."[23] With the railroad now liquidated and work on the roadway continuing, the Territorial Highway Department

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[12] Alvarez, *Historic Bridge Inventory,* 71
[13] Superintendent of Public Works, Territory of Hawaii. *Annual Report to the Governor, Territory of Hawaii Department of Public Works*. Annual Report (Honolulu: Territorial Department of Public Works, 1936).
[14] Alvarez, *Historic Bridge Inventory,* 78.
[15] Ibid.
[16] Bagasse is the fibers of the sugar cane plant after all juices have been extracted, a by-product of sugar milling.
[17] Hungerford, *Hawaiian Railroads*, 64.
[18] Tomich, *Hawaii: Perspectives*, 97.
[19] *Honolulu Star Bulletin.* "Big Island Roads Are Badly Worn By Wartime Movement to Hilo." May 17, 1946: 13.
[20] Hungerford, *Hawaiian Railroads*, 65.
[21] *Honolulu Advertiser.* "Planters on Big Isle Plan Road Program." March 16, 1946: 1.
[22] *Honolulu Advertiser,* "Bids on Hawaii Road Projects," 2.
[23] Ibid.

purchased several of the railroad's bridges and salvaged steel, building the roadway improvements on areas of the abandoned rail line.[24] Some gulches along this route would be filled rather than bridged, and the use of the rail alignment would provide for gentle grades and long sight distances.[25] In addition, five former railroad bridges, including the Hakalau Gulch bridge, were used for the new roadway. These bridges were reinforced and widened for use as a vehicular roadway by incorporating portions of other, dismantled railroad bridges from the area.[26] In June 1953 it was estimated that the Mamalahoa Highway through Hamakua was about 65 percent complete.[27] Completion was expected in 1955[28] but the highway was not finished until 1960,[29] when it was given the designation FAP (Federal Aid Primary) 19.

Although the highway did trace the rail route at some sections, a large portion of the Mamalahoa Highway ended up being built "higher up the slopes of Mauna Kea and much of the scenic beauty of the old highway was lost."[30] Because most of the sugar mills were located very close to the shoreline, the Hawaiian Consolidated Railway Co. tracks running north from Hilo to Paauilo were positioned very close (approx 1/8 mile) to the top edge of the cliff at the shoreline. From just north of Hilo, at Honoili, to about Kohola Point this distance of the railroad line from the coast was slightly greater, up to about 5/8 mile near Pepeekeo. Except for this stretch, the belt road through Hamakua in the 1920s generally followed the same positioning as the railroad tracks only from Hilo northward to the area of Ookala. Here the roadway diverted inland along Kaula Gulch and then ran about a mile inland of the shoreline to Paauilo. The path of the roadway angled slightly more inland the further up the coast from Paauilo it went, being about 1½ mile inland at Honokaa.

When it was improved in the 1930s to 1960, the route of the Mamalahoa Highway mostly followed the general position of the earlier belt road, gradually moving closer to the coastline from Honokaa to Ookala and then mingling with the pathway of the railroad as it extended south from Ookala to Hilo. Near Pepeekeo the Mamalahoa Highway moves away from the rail path and traverses well inland (approximately 1 mile).

Hawaii Belt Road and the Kawailii Bridge

With the establishment of county governments in the Territory of Hawaii in 1905, the counties were given the power to appropriate and spend funds for road building through the County Board of Supervisors. However, because the counties were chronically short of funds and roads were not being built or maintained adequately, the Territorial Legislature made bonds available in 1911 for belt road construction on the islands. In 1912, two contracts were let for the reconstruction of the Hawaii belt road, one from just north of Hilo to Hakalau, and the other for the stretch from Hakalau to Pohakupka.[31] That year, concrete was being specified "as far as funds permit"[32] for the construction of new bridges. It replaced steel and masonry (lava rock). Timber was an option for some bridge construction "if funds get low."[33] From 1912 through 1960, the belt road through Hamakua was constructed in short pieces as funds became available.

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[24] Alvarez, *Historic Bridge Inventory*, 52.
[25] *Honolulu Advertiser.* "Hamakua Road Will Follow Old Rail Route." February 11, 1947: 2.
[26] *Honolulu Star Bulletin.* "Hamakua Railroad Bridges Made Part of Road System." April 29, 1953: C4.
[27] *Honolulu Advertiser.* "Governor King To Dedicate New Route Unit." June 26, 1953: Sec III, p. 1.
[28] Superintendent of Public Works, *Annual Report*, 1952, 14.
[29] Alvarez, *Historic Bridge Inventory,* 80.
[30] *Honolulu Star Bulletin,*"Scenic Roads to Reveal Hidden Beauty," March 25, 1967, A4.
[31] Alvarez, *Historic Bridge Inventory,* 59.
[32] *Hilo Tribune,* "Belt Road Work to Start at Wainaku," January 16, 1912, 1.
[33] Ibid.

A 1915 USGS topographic map of the area shows that the Government Road crossed Kawaili Stream at the same site as the present (1938) bridge crossing. When the present bridge was built, the road grade was raised about 10' at the bridge by building atop the stonework of the earlier bridge foundation. This is evidenced by the remnants of the earlier bridge abutments (construction date unknown) that remain visible in the gulch at the foundation of the present bridge.

In March 1924, the Territory of Hawaii became a participant in a federal aid program that provided construction funds for roads. The Territory designated up to 7 percent of its roads as federal aid system roads (usually belt roads or those linking a seaport with federal property such as a military base or a national park). The federal government then provided construction funds for those roads on a matching 50-50 basis with the Territory. These funds allowed the construction of bridges with well-built (and expensive) foundations that would withstand the frequent and violent flash floods that plagued previous bridges along the Hamakua Coast. By the mid 1930s, the Territory was receiving $1m in grants per year for federal aid roads. A tax on fuel made up the Territory's matching share. By 1937, the Territory was having difficulty in meeting the matching fund requirements of the federal grants, and bonds were used to supply the shortfall. In 1939 a gasoline tax increase to pay off the bonds and raise additional matching funds was unable to pass the Territorial legislature and the Territory had to forfeit federal funds that it could have used, thus scaling back on its highway construction program.[34]

During the late 1930s another federal road aid program existed outside of the aid that required matching funds. This federal program made money available to remove railroad grade crossings and did not have to be matched by territorial funds. It was planned to build several bridges along the Hamakua coast using this program. One concrete deck girder design was built at Honolii in 1937, but others planned for the belt road under this program were not built. World War II intervened to halt most roadwork until 1946, when the Highway Department's "first post-war priority was the Hamakua Coast Highway."[35] Several factors combined to make this area high priority for the territory; previous upgrading and straightening had been spotty, accelerated wear from military traffic degraded the road, and the demise of the Hawaiian Consolidated Railway left the winding belt road as the only way for large trucks to carry sugar to Hilo.

In the 1930s:

> "bridges were a special concern on the federal highway system and the [Territorial] highway department began a systematic replacement of narrow and hazardous ones. In addition, because of its ample funds, the department could begin to straighten the belt road and build long, high bridges that earlier superintendents would have envied. Along the Hamakua Coast and in Kau it erected numerous concrete deck-girder and slab bridges."[36]

The Kawailii Bridge was built as part of Federal Aid Project No. 26-A and drawings were prepared in January and February 1938.[37] In addition to building the Kawailii Bridge, this project realigned a section of the Hawaii Belt Road extending eastward approximately 1¼ miles from about Aamanu Gulch. Original plans show that although this re-alignment called for the re-positioning of several bridges along the route, the 1938 Kawailii Bridge was built over the site of

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[34] Alvarez, *Historic Bridge Inventory,* 70
[35] Alvarez, *Historic Bridge Inventory,* 77.
[36] Alvarez, *Historic Bridge Inventory,* 71
[37] Hawaii Department of Transportation, (HDOT) Design Branch, "Plans of Hawaii Belt Road, Federal Aid Project No. 26-A," construction plans in the HDOT database, 1938.

the existing bridge. In addition, the masonry abutments for the 1938 were built atop the existing abutments.[38] A note on the original drawings states, "Existing abutments 1 & 2 are in perfect condition."[39]

The Kawailii Bridge was designed by William Bartels, engineer for the Territory's Highway Department from 1932 until his retirement in 1957. Bartels was responsible for the design of most of the territorial bridges during his tenure. He retired at age 70 as Chief of the department's Bridge Division. The draftsman for the original drawings was William Yannatta. The Kawailii Bridge is a tee-beam design concrete deck bridge. This type of bridge became popular around 1918-1919, initially chosen for short spans over small arched designs. The strength and relative low cost of this design prompted its use in replacing longer, open spandrel arched designs.[40] The builder was contractor Otto Medeiros who constructed many of the federal aid project bridges along the Hamakua Coast.[41]

The Kawailii Bridge, built in 1938, was one of the last bridges built on the Hamakua Coast section of the belt road before the beginning of World War II. It was built during the time when decreasing territorial tax revenues caused by the 1930s depression shut off the supply of federal aid due to the inability of the Territory to match funds. This forced the adoption of less expensive materials (namely, wood) in the construction of large bridges in the area. A number of bridges built in Hamakua at the same time as the Kawailii Bridge were constructed using timber to reduce costs. Possibly, because the Kawailii Bridge's span was so short, thus requiring a smaller amount of construction materials, it was built of concrete.

> "Budget restraints made their impact felt on construction materials beginning in 1937, when the territory no longer matched incoming federal funds. Among the last bridges of the era were four steel and timber bridges at Kainehe, Kaholalele, Paauilo School Road and Paauilo. A short span of 40 feet at Kawaili, built at the same time, was of concrete tee-beam design, but the larger spans were made of timber bents and steel frames.[42]

The tee-beam design of the Kawailii Bridge represents the most common remaining type of pre-World War II bridges in the state. It is generally not possible to distinguish this tee-beam design from a concrete girder deck bridge by observation only. The two types differ in the internal configuration of their steel reinforcing, which is not apparent on exterior examination. The internal configuration of the reinforcing that accounts for the difference is the tee-beam design's use of vertical reinforcing to tie the reinforcing of the girders to the reinforcing of the deck slab. This is apparent on the original drawings for the Kawailii Bridge.[43] These show ½" reinforcing rods extending up from the longitudinal reinforcing of the beam. These rods are bent into stirrups at their upper ends that are looped over the longitudinal reinforcing of the deck slab. In addition, the reinforcing plan shows that the two center beams (with no clearance between them) are actually keyed together by a 1'-0" high, 3" protruding male key on the south beam that fits a corresponding female keyway on the north beam.[44]

When building these bridges during the 1930s and 1940s the Territorial Highway Department generally utilized one of three typical standard rail patterns for the parapet/ balustrade; cross,

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[38] HDOT, "Plans of Hawaii Belt Road," Drawing s "Title Sheet," 1 of 1 and "Bridge Details" 15 of 17."
[39] HDOT, "Plans of Hawaii Belt Road," Drawing "Bridge Details," 17 of 27.
[40] Alvarez, *Historic Bridge Inventory,* 72-73.
[41] Alvarez, Historic *Bridge Inventory*, 291b.
[42] Alvarez, *Historic Bridge Inventory,* 74.
[43] HDOT, "Plans of Hawaii Belt Road," Drawing "Bridge Details," 16 of 27.
[44] Ibid.

arched, or rectangular openings. These designs typically used a wider concrete rail cap. End stanchions were commonly concrete in a squat rectangular form, often with stepped treatments at the corners and occasionally with a low profile pyramidal top. The Kawailii Bridge's construction shows the use of most of these typical treatments.

Sources

A. Architectural Drawings:

Drawings for the Kawailii Bridge are available at the Hawaii Department of Transportation, Design Branch Office, Kapolei, Hawaii. These are scanned images in an electronic database. These drawings include several from the original set of 1938 plans and also from later projects.

The drawings are retrieved by project number, drawing set title, and sheet number. Drawings located in the database are:

Project: FAP 26-A (yr. 1938)	Title Sheet	1 of 1
	Plan & Profile	1, 2, 3 of 3
	Bridge Details	15, 16, 17 of 27
	Cross Sections	5, 6 of 10
Project: SDR 3(6) (yr. 1949)	Title Sheet	1 of 1
	Plan & Profile	3 of 9
Project: 19G-01-90M (yr. 1990)	Title Sheet	1 of 1
	Rdwy, striping & Constr Plan	1 of 2
Project: NH-019-2(55) (yr. 2004)	Title Sheet	1 of 2
	Roadway Plans	2 of 7
	Index to Bridge Dr.	1 of 1
	Kawaili[sic] Bridge	1-16 of 16

B. Early Views:

No historic photos of the Kawailii Bridge were located. Aerial photos taken from a high altitude (22,500' & 23,000') in 1954 are available at the Hawaii State Archives, folder PPA-13-2 (photo 1-46, September 28, 1954) and folder PPA-13-5 (photo 4-77, October 6, 1954). Topographic and other maps showing the historic path of the Mamalahoa Highway are available at Hawaii State Archives. Topo map, year 1915 call # G4382.H3:2H25 1913 .U54.G4 half. Year 1941 call # G4382.H3:2H25 1941 .U54.A7 half. Year 1957 call # G4382.H3:3P2 1957 .U54.G4 half.

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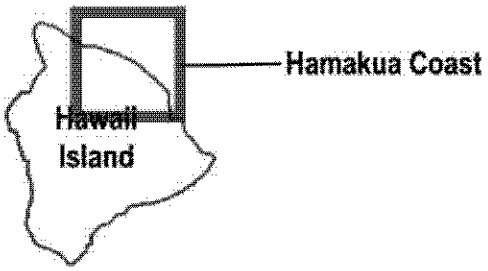
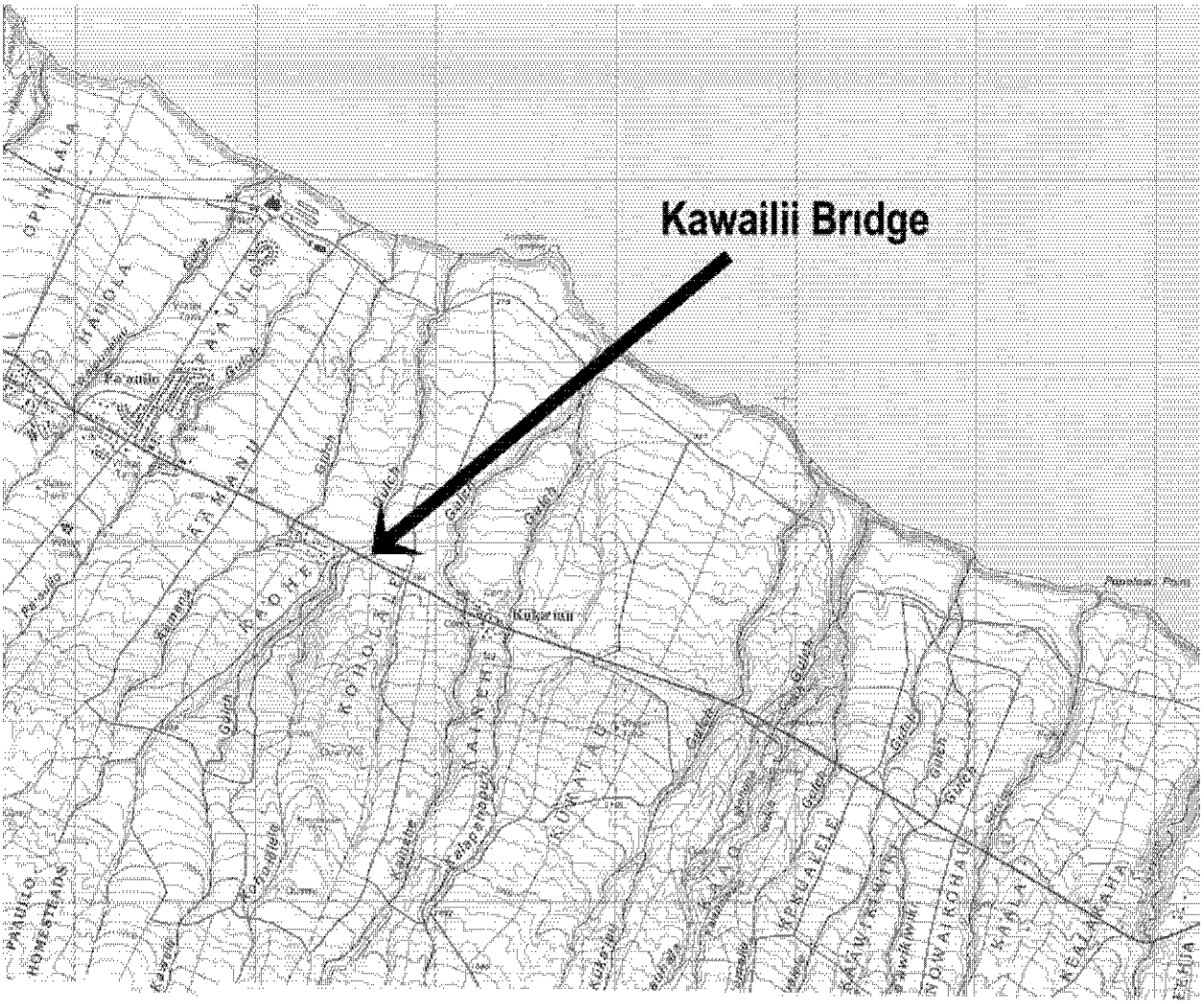
PROJECT INFORMATION

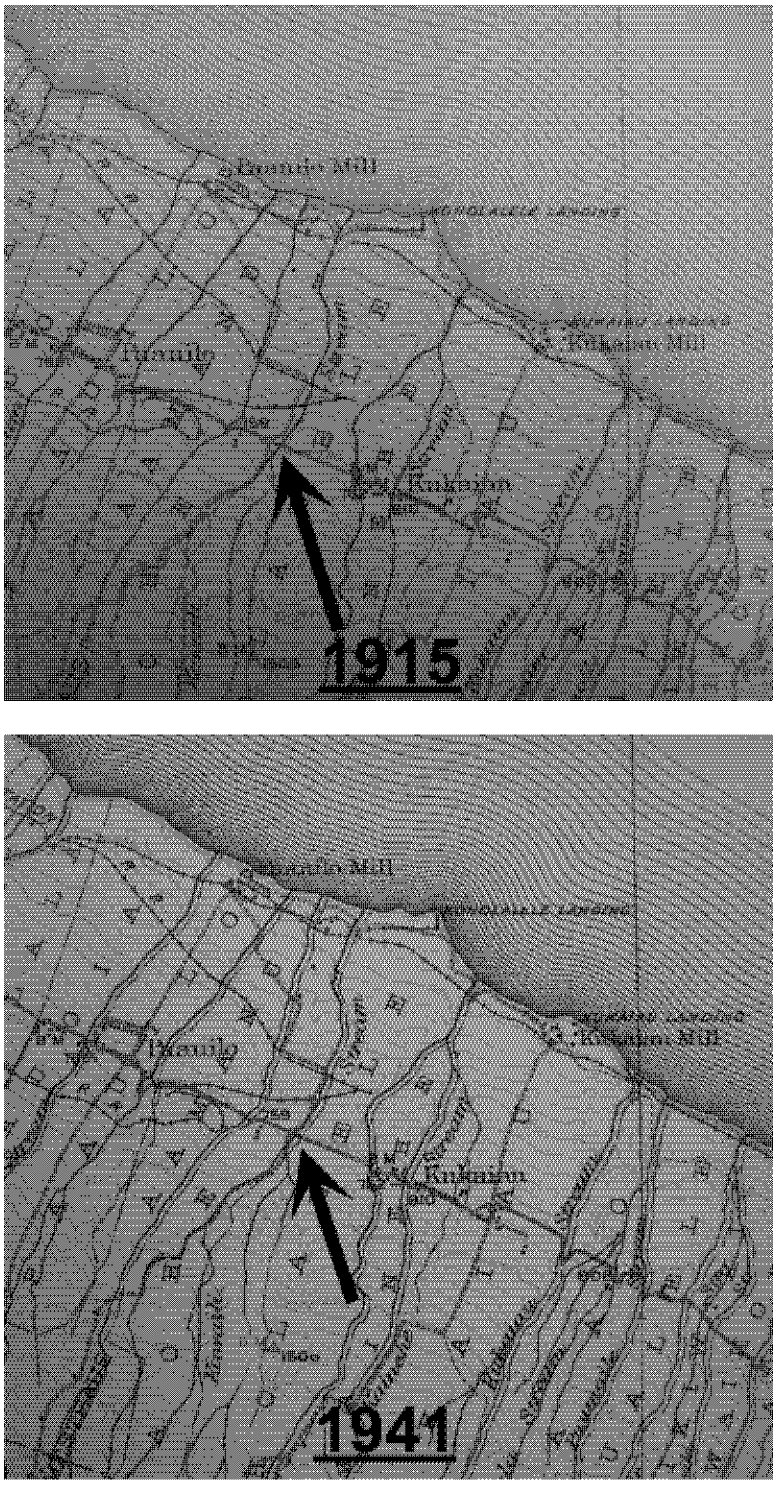
This report was produced in conjunction with the replacement of the Kawailii Bridge for the State of Hawaii, Department of Transportation, Highways Division under project: Hawaii Belt Road, Kawailii Stream Bridge Replacement: Federal Aid Project No. ER-15(3), District of Hamakua, Island of Hawaii. A section of the east approach to the bridge was damaged in an earthquake on October 15, 2006. The bridge will be demolished and a new bridge, abutments, wing walls, retaining walls, end posts, and approach slabs will be built and the stream bed stabilized. The research, field work, and writing of this report was done by Dee Ruzicka of Mason Architects, Inc. in July 2010 and the photographs were taken by David Franzen of Franzen Photography in July 2010.

Project Location

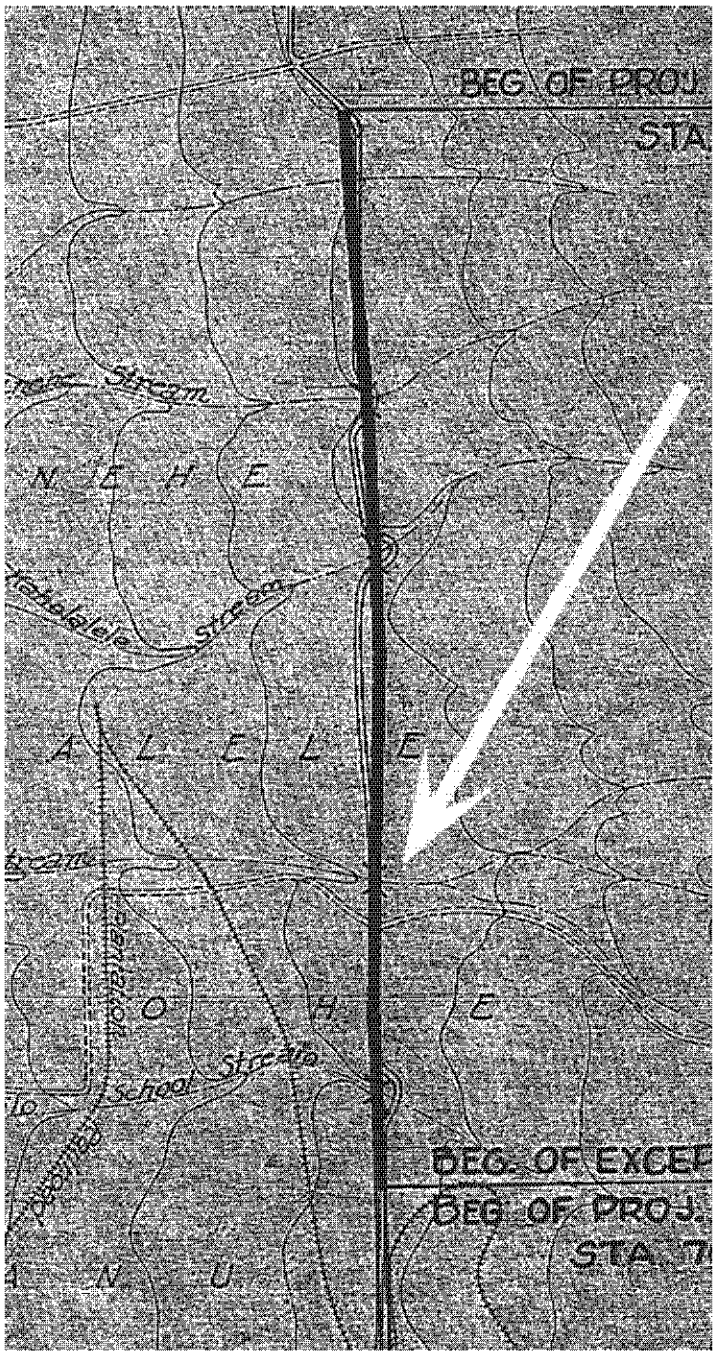




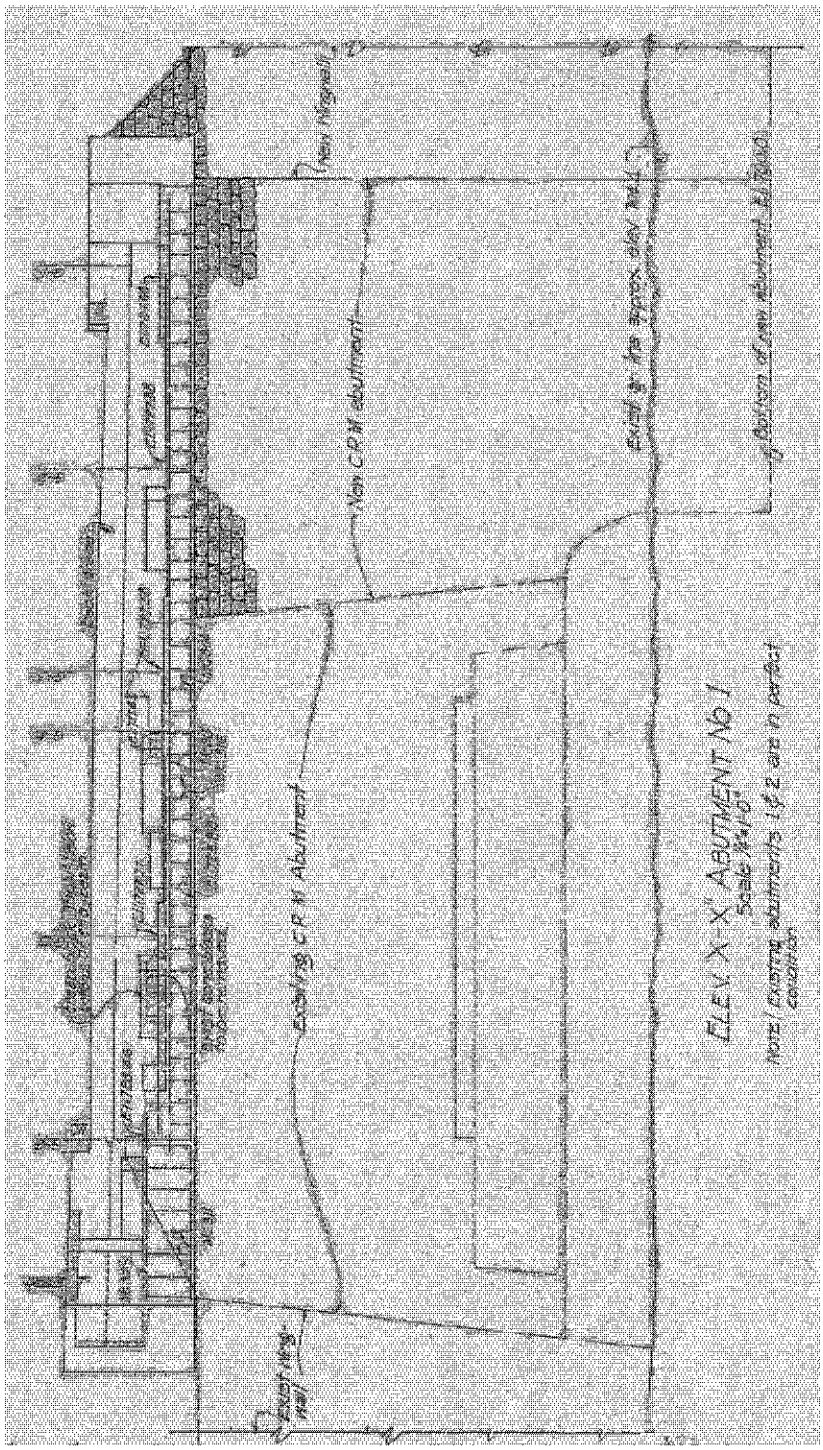
Comparison of 1915 USGS topographic map (top) and 1941 USGS topographic map (bottom). Showing the path of the belt road and the locations of the earlier Government Road bridge (1915) and the present Kawailii Bridge (1941). Arrows and dates added. Note the Hawaii Consolidated Railway Co. line running along the coast to Paauilo. Additional spurs inland from the coast were part of plantation rail systems. Although the belt road nearer to Hilo followed some railroad right-of way, the Kawailii Bridge was never a part of a rail system.



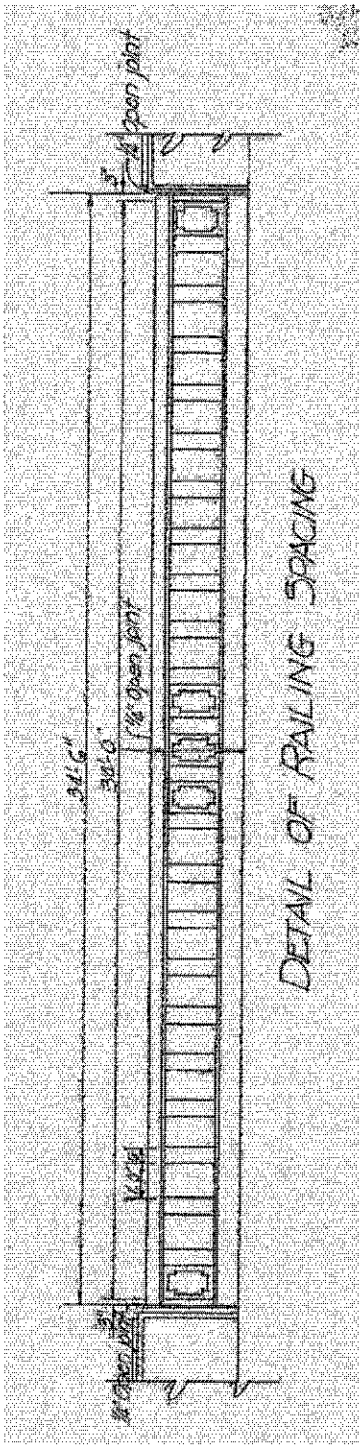
Portion of original drawing for the Kawailii Bridge dated January 1938. This portion of the Title Sheet shows the planned route of the Hawaii Belt Road (dark line route) overlaid on the existing route of the highway (outline route). Note that the realignment places three bridges in new locations while the Kawailii Bridge (highlight arrow added) runs directly over the existing bridge, enabling the existing abutments to be incorporated into the new construction. No scale, north is at bottom left. (Hawaii Department of Transportation, Design Branch, "Plans of Hawaii Belt Road, Federal Aid Project No. 26-A, Title Sheet," 1938)



Portion of original drawing for the Kawailii Bridge dated January 1938 showing the position of the existing abutment at the east bank of the gulch within the planned construction. Note at the bottom of this drawing reads "Existing abutments 1 & 2 are in perfect condition." No scale. (Hawaii Department of Transportation, Design Branch, "Plans of Hawaii Belt Road, Federal Aid Project No. 26-A, Kawailii Bridge, sheet 17 of 27," 1938)



Portion of original drawing for the Kawailii Bridge dated January 1938 showing a detail of the parapet/ balustrade. No scale. (Hawaii Department of Transportation, Design Branch, "Plans of Hawaii Belt Road, Federal Aid Project No. 26-A, Kawailii Bridge, sheet 15 of 27," 1938)



Portion of original drawing for the Kawailii Bridge dated January 1938 showing a cross section through the longitudinal girders. This detail shows the vertical reinforcing that ties the horizontal reinforcing at the lower portion of the girders to the reinforcing of the deck. Also note the key in girders 3 & 4 (right), the two center girders of the bridge. No scale. (Hawaii Department of Transportation, Design Branch, "Plans of Hawaii Belt Road, Federal Aid Project No. 26-A, Kawailii Bridge, sheet 16 of 27," 1938)